

## Consumable-Based Cooling for 24 Hour Life Venus Lander, Phase I

Completed Technology Project (2018 - 2019)



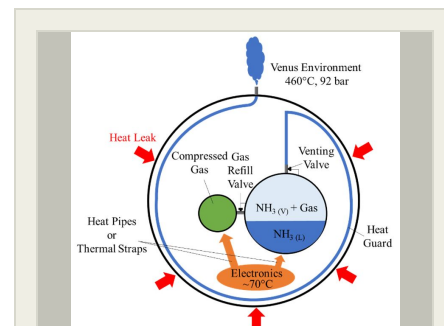
## Project Introduction

A reliable thermal management system that will enable at least 24-hours survival of Venus landers in the extreme environment (460°C, 92 bar) is highly desirable for NASA future Venus in-situ exploration missions. In response to the NASA SBIR solicitation, Advanced Cooling Technologies, Inc. (ACT) proposes to develop a consumable-based cooling system for Venus landers waste heat rejection. The proposed system consists of two pressurized vessels: a primary vessel charged with a consumable fluid in a saturation state (ammonia) and a secondary vessel filled with compressed gas. The main role of the compressed gas is to help ammonia vapor venting into a higher-pressure environment than the vapor pressure that corresponds to the cooled electronics temperature. Through venting a mixture of consumable vapor and compressed gas to the Venus ambient, a significant amount of evaporative cooling (primary) and Joule-Thompson cooling (secondary) can be achieved, which not only will keep the electronics temperature cool but also provide heat guarding by collecting and removing the incoming heat leaks from Venus environment. In Phase I, a proof-of-concept consumable based prototype will be fabricated and tested. Test results will be used to validate a mathematical model. After validation, the model will be employed to design the full-scale prototype and optimize mass and thermal performance. A preliminary modeling result shows a thermal management system total mass (fluids and structure) of 75kg.

## Anticipated Benefits

The proposed consumable-based cooling system represents a passive, low-mass and effective thermal management solution that will enable a Venus lander to survive and operate for more than 24 hours in the extreme environment, making the future Venus "human-in-the-loop" mission durable. The innovative thermal management technology will be beneficial to several planned Venus in-situ exploration missions such as Flagship and New Frontiers missions.

The consumable-based cooling technology can be applied to thermal management systems in high pressure environments, such as small-scale unmanned undersea vehicles (UUV) or submarines. It can also be used to cool military electronics by vapor venting.



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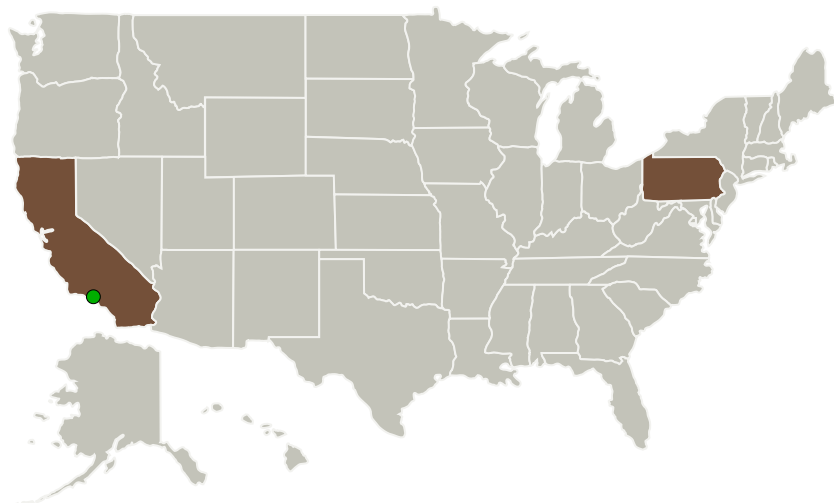
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## Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Advanced Cooling Technologies, Inc.	Lead Organization	Industry	Lancaster, Pennsylvania
● Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations	
California	Pennsylvania

## Project Transitions

▶ **July 2018:** Project Start

✓ **February 2019:** Closed out

## Closeout Documentation:

- Final Summary Chart(<https://techport.nasa.gov/file/141318>)

## Organizational Responsibility

## Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

## Lead Organization:

Advanced Cooling Technologies, Inc.

## Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

## Project Management

## Program Director:

Jason L Kessler

## Program Manager:

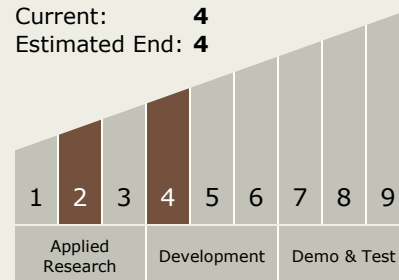
Carlos Torrez

## Principal Investigator:

Calin Tarau

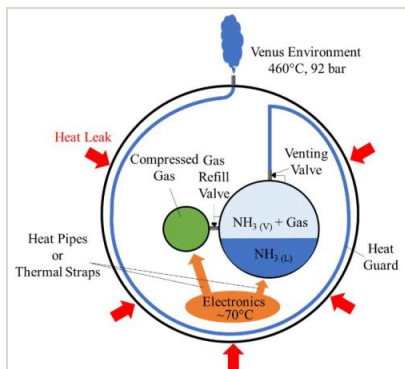
## Technology Maturity (TRL)

Start: 2  
Current: 4  
Estimated End: 4



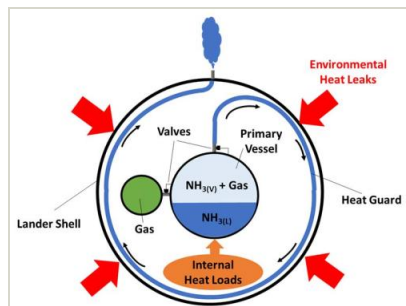


## Images



### Briefing Chart Image

Consumable-Based Cooling for 24 Hour Life Venus Lander, Phase I  
(<https://techport.nasa.gov/image/129143>)



### Final Summary Chart Image

Consumable-Based Cooling for 24 Hour Life Venus Lander, Phase I  
(<https://techport.nasa.gov/image/131061>)

## Technology Areas

### Primary:

- TX14 Thermal Management Systems
  - └ TX14.2 Thermal Control Components and Systems
    - └ TX14.2.2 Heat Transport

## Target Destination

Others Inside the Solar System